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June 19, 2017

VIA ELECTRONIC FILING

Marlene H. Dortch, Secretary
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

Re: Written *Ex Parte* Notice, GN Docket No. 14-177, IB Docket Nos. 15-256 and 97-95; RM-11664; and WT Docket No. 10-112

Dear Ms. Dortch:

The Boeing Company (“Boeing”), through its counsel, hereby responds to the May 17, 2017 letter filed by Straight Path Communications Inc. (“Straight Path”) challenging Boeing’s detailed showings that reasonable regulatory measures can be adopted that would enable robust and highly beneficial spectrum sharing in the 37.5-40.0 (“37/39”) GHz band. Such spectrum sharing would ensure that all Americans could enjoy the benefits of very high speed broadband services provided using millimeter wave (“mmW”) frequencies.

Maximum Power for UMFUS Base Stations

Straight Path challenges Boeing’s position that the maximum power for base stations in the Upper Microwave Flexible Use Service (“UMFUS”) should be reduced from 75 dBm/100 MHz to 65 dBm/100 MHz,¹ which is much closer to the 62 dBm/100 MHz level that was originally proposed in the Commission’s Notice of Proposed Rulemaking.² Straight Path argues that the much higher power level is needed so that UMFUS can be used to provide wide area coverage.³ Straight Path posits that 37/39 GHz spectrum is far superior for wide area coverage than much higher spectrum bands such as 60 GHz.⁴

¹ See Letter from Bruce A. Olcott, Counsel to The Boeing Company, to Marlene H. Dortch, Secretary, Federal Communications Commission, GN Docket No. 14-177 *et al.*, Attachment at 3 (March 31, 2017).

² See Use of Spectrum Bands Above 24 GHz For Mobile Radio Services, GN Docket No. 14-177, *Notice of Proposed Rulemaking*, FCC 15-138, ¶ 270 (Oct. 23, 2015) (“*NPRM*”).

³ See Letter from Davidi Jonas, President and CEO and Jerry Pi, Chief Technology Officer, Straight Path Communications Inc., to Marlene H. Dortch, Secretary, Federal Communications Commission, GN Docket No. 14-177 *et al.*, at 12 (May 17, 2017) (“*Straight Path Letter*”).

⁴ See *id.*

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Of course, the opposite is also true – 37/39 GHz spectrum is exponentially less effective in providing wide area coverage as compared to low or mid-band frequencies. Therefore, any wireless operator that has access to significant amounts of low and mid-band spectrum would be prudent to use its low and mid-band spectrum for wide area coverage and its 37/39 GHz band spectrum for high-capacity small cell deployments. As one major wireless carrier recently explained, “[s]mall cells are fundamental building blocks for the 4G densification and 5G deployment to bring next-generation wireless services to consumers.”⁵

Thus, although Straight Path has previously suggested that it may use its 37/39 GHz spectrum to construct a wide area mobile network, recent news reports have made clear that Straight Path’s licenses will ultimately be controlled by a major wireless carrier.⁶ Therefore, it is no longer tenable (if it ever was) to conclude that 37/39 GHz spectrum will be used for wide area services. This outcome is consistent with the conclusions of the International Telecommunication Union (“ITU”) study process leading up to the 2019 World Radiocommunication Conference (“WRC-19”). In considering the potential deployment scenarios for terrestrial mmW systems, Working Party 5D rejected the possibility of rural deployments, concluding that even in urban areas, terrestrial mmW deployments will exist only in the most densely populated locations, covering no more than 10 percent of the area within each city.⁷

Given the near-uniform consensus that mmW spectrum is optimal for small cell, high density coverage, the Commission must reconsider its decision to adopt a base station power limit for UMFUS systems that is twenty times higher than what was originally proposed. UMFUS systems have no need for such high power transmissions. Instead, UMFUS operations at or near 75 dBm would cause intra-system interference within and between UMFUS networks and would greatly impair the ability of broadband satellite networks to serve consumers in the 37/39 GHz band on an opportunistic basis.

⁵ Letter from William H. Johnson, Senior Vice President, Federal Regulatory and Legal Affairs, Verizon, to Marlene H. Dortch, Secretary, Federal Communications Commission, GN Docket No. 14-177 *et al.*, at 12 (May 17, 2017).

⁶ See, e.g., Straight Path Said Monday a Rival Bidder to AT&T’s Offer to Buy the Company, *Communications Daily* at 24-25 (May 19, 2017) (“*Communications Daily Article*”).

⁷ See Working Party 5D: Attachment 2 on Spectrum Needs to a Liaison Statement to Task Group 5/1, at 6-7 (Feb. 28, 2017).

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Beamforming and Power Control

Straight Path also challenges Boeing's argument that the Commission should require UMFUS licensees to employ beamforming and power control.⁸ Straight Path acknowledges that both beamforming and power control are generally used in current cellular systems.⁹ Straight Path argues, however, that neither technology was mandated by the Commission.¹⁰ In fact, Straight Path's own 39 GHz licenses are already subject to both beamforming and power control requirements, which the Commission imported into its Part 30 rules for UMFUS licensees providing fixed services. Specifically, Section 30.406(b) specifies maximum beamwidth and off-axis transmission limits (effectively beamforming requirements) for fixed point-to-point transmitters.¹¹ In addition, Section 30.405 instructs that the "the average power delivered to an antenna in [the UMFUS] service must be the minimum amount of power necessary to carry out the communications desired."¹² Similar power control requirements exist in the Commission's rules for many other wireless services.¹³

The Commission's beamforming and power control requirements for UMFUS licensees, however, currently apply only to UMFUS systems providing fixed point-to-point and fixed point-to-multipoint services.¹⁴ The Commission should therefore adopt comparable regulations governing all UMFUS operations, including mobile services. Granted, as Straight Path suggests, many UMFUS licensees are likely to employ beamforming and power control to avoid intra-system interference.¹⁵ Such measures should be required by the Commission, however, to create sufficient regulatory certainty to permit operators of broadband satellite networks to serve consumers on an opportunistic basis in 37/39 GHz frequencies.

⁸ See *Straight Path Letter* at 12.

⁹ See *id.*

¹⁰ See *id.*

¹¹ See 47 C.F.R. § 30.406(b) (importing from Part 101 maximum beamwidth and off-axis transmission limits for fixed point-to-point transmitters).

¹² 47 C.F.R. § 30.405.

¹³ For example, the Commission adopted power control rules for the Citizens Broadband Radio Service, see 47 C.F.R. § 96.41(c), for white space devices in television broadcast spectrum, see 47 C.F.R. § 15.709(a)(4), for Unlicensed National Information Infrastructure (U-NII) devices, see 47 C.F.R. § 15.407(h), and for Wireless Communications Service devices. See 47 C.F.R. § 27.50(a).

¹⁴ See Part 30, Subpart E (entitled "Special Provisions for Fixed Point-to-Point, Fixed Point-to-Multipoint Hub Stations, and Fixed Point-to-Multipoint User Stations").

¹⁵ *Straight Path Letter* at 13.

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High-Density Spectrum Sharing

Straight Path further argues that it would be “inappropriate” for the Commission to adopt rules that enable high density deployment of both terrestrial wireless and broadband satellite systems in the 37/39 GHz band.¹⁶ The Commission’s statutory public interest mandate, however, requires that such rules be adopted if they help ensure that all Americans have access to the high-speed broadband services that can be made available using mmW spectrum. The highly directional beamforming capabilities of mmW technologies make such spectrum sharing fully achievable. Therefore, no basis exists for Straight Path’s argument that such sharing would be inappropriate.

Straight Path then asserts that the Commission should not alter its proposed limit of three protected gateway earth stations in each partial economic area (“PEA”), claiming that such a proposal already gives satellite operators more spectrum usage rights than they currently possess in the 37/39 GHz band.¹⁷ The central focus of the Spectrum Frontiers proceeding, however, is providing greater flexibility for users of mmW spectrum in order to encourage the provision of new services to consumers. To the extent possible, additional flexibility should be made available to all allocated services. For example, 39 GHz licensees such as Straight Path were granted tremendous additional flexibility to use their fixed service spectrum in the 39 GHz band to provide mobile services, an enormous windfall that is reflected in Straight Path’s current market valuations.¹⁸ The fact that satellite services require a modest level of additional flexibility as compared to what was proposed in the *Further Notice* is hardly unreasonable.

Straight Path also opposes allowing satellite end user terminals to operate in the 37/39 GHz band on an opportunistic basis.¹⁹ Straight Path claims such operations would be “devastating” to terrestrial wireless deployment because it would require the Commission to increase the power flux density (“PFD”) limit by 12 dB for satellite downlink transmissions in the 37/39 GHz band.²⁰ In making this argument, Straight Path disregards the fact that the Commission’s rules already do include two different PFD limits for satellite transmissions in the

¹⁶ *Id.*

¹⁷ *Id.*

¹⁸ See *Communications Daily Article* at 24-25 (quoting an industry analyst as explaining that “[i]n the span of just a few weeks, the value of millimeter wave spectrum has risen from about \$0.009 per MHz-POP, to \$0.017 per MHz-POP”).

¹⁹ See *Straight Path Letter* at 13.

²⁰ *Id.*

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37/39 GHz band, a limit of $-117 \text{ dBW/m}^2/\text{MHz}$ for operations in clear sky conditions and a second limit of $-105 \text{ dBW/m}^2/\text{MHz}$ for operations during periods of rain fade.²¹

Boeing is not asking the Commission to change these limits. Boeing is instead requesting the Commission to complete the studies that it has already codified as necessary. Specifically the Commission should define the conditions under which individual satellites are permitted to increase their transmit PFD levels toward the Sections 25.208(q)(2) and (r)(2) limits to compensate for rain fade.²² The Commission should complete this task through the adoption of equivalent power flux density (“EPFD”) limits that can be used to restrict satellite downlink transmissions (both individually and in the aggregate) to ensure that the operations of such satellites do not cause harmful interference to UMFUS base stations or end user receivers in the 37/39 GHz band. Such measures would enable high density deployment of both UMFUS and broadband satellite systems in the 37/39 GHz band without encumbering the robust growth or operation of either service.

Multipath Analysis

Straight Path’s letter also attempts to criticize the exhaustive technical studies that Boeing performed to demonstrate that multipath signals from satellite downlink transmissions will not increase interference to an appreciable extent into UMFUS receivers operating in the 37/39 GHz band. As Boeing’s analysis demonstrates, multipath signals from satellite downlink transmissions will have only a negligible impact on UMFUS receivers. Further, in many situations (particularly in urban conditions) the increased interference from reflected satellite transmissions will be more than offset by reduced transmissions resulting from the blockage of satellite transmissions by large buildings. Boeing’s extensive and fully realistic analysis provides a far more credible basis for assessing spectrum sharing between satellite services and UMFUS in the 37/39 GHz band than the simplistic, incomplete and overly conservative analyses that Straight Path includes in its letter.

Pointing Assumptions

Straight Path’s concern about multipath signals includes a persistent misconception about Boeing’s technical analysis. Boeing has always assumed in its technical studies that UMFUS receivers could point randomly in all directions (including directly at transmitting satellites overhead), rather than steering toward their intended UMFUS user or base station transmitters. Boeing details this aspect of its technical analysis yet again in the opening pages of its May 15 *ex*

²¹ See 47 C.F.R. 25.208(q) and (r) (specifying the above limits for angles of arrival between 25 and 90 degrees above the horizontal plane).

²² See 47 C.F.R. § 25.208, Note to subsections (q) and (r).

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parte presentation.²³ Nevertheless, Straight Path continues in its misconception, arguing that Boeing “continues to ignore” that some UMFUS base station receivers may have to point upward to receive communications from UMFUS end user devices inside buildings.²⁴ Although such network configurations seem highly unlikely given the significant attenuation of high rise building surfaces, Boeing has always assumed that some UMFUS receivers will point upward and has always included this scenario in its analysis. In fact, Boeing’s pointing assumptions yield the upward pointing case much more frequently than is dictated by the 3GPP reference, causing another degree of “worst-case” in Boeing’s analysis. Boeing has also shown that an UMFUS receiver pointing at a relatively high elevation angle toward a building (*i.e.*, high enough to point directly toward a transmitting satellite) will often be close enough to the building to benefit from the natural shielding that the structure will provide blocking the satellite.

Straight Path’s preoccupation with upwardly-pointing UMFUS base stations toward buildings seems remarkable given Straight Path’s acknowledgement in its most recent letter that indoor usage of 5G in the 37/39 GHz band is unlikely.²⁵ As Straight Path explains “Wi-Fi hotspots in unlicensed bands and small cells in licensed and unlicensed bands can already provide good capacity for such deployment scenarios.”²⁶ Straight Path therefore explains that mobile network deployments involving the 37/39 GHz band to serve indoor locations would “not add significant value to mobile services to American consumers.”²⁷ Therefore, it remains unclear why Straight Path continues to be concerned about serving users using upwardly-pointed UMFUS base stations toward large buildings.

Verification of OSM Building Data

In a further effort to discredit Boeing’s multipath analysis, Straight Path argues that data omissions exist in the Open Street Map Buildings (“OSM Buildings”) database that Boeing used as the basis for the cities that it modeled in its multipath analysis.²⁸ Straight Path identifies a

²³ See Letter from Bruce A. Olcott, Counsel to The Boeing Company, to Marlene H. Dortch, Secretary, Federal Communications Commission, GN Docket No. 14-177 *et al.*, Attachment at 4-5 (filed May 15, 2017) (“*Boeing Multipath Ex Parte*”).

²⁴ See *Straight Path Letter* at 3.

²⁵ See *id.* at 12.

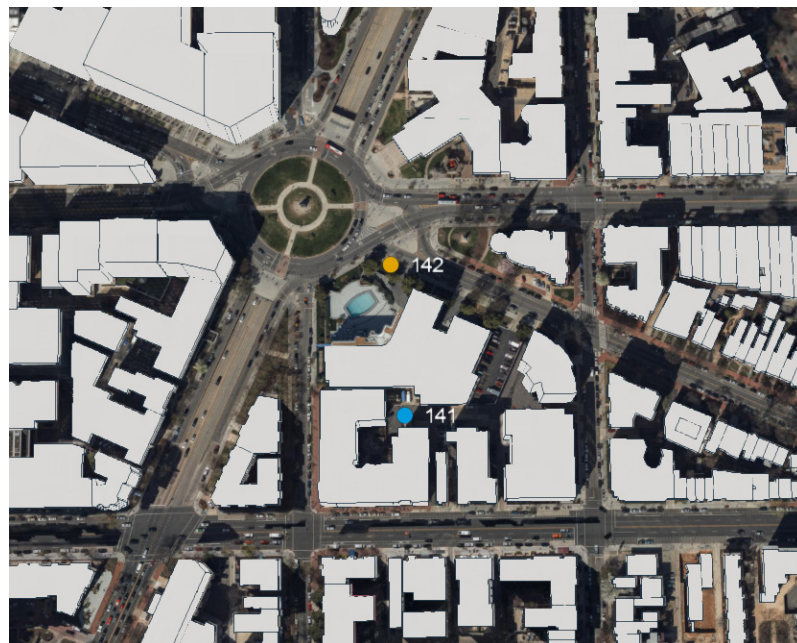
²⁶ *Id.* (further explaining that “[i]n serving capacity needs in indoor and static environments, operators already have a multitude of tools to address that demand. ... This is evident in the fact that many business venues, e.g., hotels, convention centers, and restaurants, are providing free Wi-Fi access to their customers.”).

²⁷ *Id.*

²⁸ See *id.* at 3-4.

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residential housing development near Dallas, Texas, the building data for which is poorly reflected in the OSM Buildings database.²⁹ This housing development is more than 200 miles from the closest city (Houston) that Boeing modeled in its multipath studies and could not have an impact on Boeing's results. More importantly, Boeing was already aware that the OSM Buildings database contains omissions. Boeing therefore ensured that the OSM Building data was accurate in each of the locations that was used in its analysis. This is one of the reasons why Boeing displayed the OSM Buildings data on top of satellite imagery as depicted in the example in Figure 1 below.



**Figure 1 - All Scenes Modeled Use Valid Building Data from OSM Database
(example shows Thomas Circle in Urban Washington DC)**

In Boeing's May 15 *ex parte* presentation, Boeing expanded its multipath interference assessment to include a total of 22 different urban and suburban scenes located within nine different cities across the United States. The May 15 presentation shows detailed images of the exact areas used in the analysis, each one with a full neighborhood of buildings modeled (as previously stated, the areas under study were specifically chosen to meet this criteria).³⁰ Table 1 below tabulates the building density in each of these cases. The buildings range anywhere from single-story homes to high rise office buildings exceeding thirty floors. (Note that some urban

²⁹ *See id.*

³⁰ *Boeing Multipath Ex Parte*, Attachment A at 8-11

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scenes have a lower building density than non-urban scenes because the former often include very large buildings separated by very wide streets.)

Metro Area	Environment	Neighborhood	Building Density (#/km²)
Atlanta	Suburban	Morningside	231
Atlanta	Urban	Midtown	202
Chicago	Suburban	Evanston	90
Chicago	Urban	Rogers Park	401
Houston	Suburban	Lawndale	520
Houston	Urban	Downtown	82
Los Angeles	Suburban	Westchester	570
Los Angeles	Urban	Financial District	130
Miami	Suburban	Kendale Lakes	319
Miami	Urban	Downtown	195
Miami	Urban	Burlingame	51
New York	Suburban	Highlands	1040
New York	Suburban	White Plains	477
New York	Urban	Times Square	140
New York	Urban	Financial District	212
New York	Urban	Brooklyn	1096
San Francisco	Suburban	San Mateo	308
San Francisco	Urban	Financial District	370
Seattle	Suburban	Laurelhurst	649
Seattle	Urban	Downtown	219
Washington DC	Suburban	Foxhall Crescent	555
Washington DC	Urban	Thomas Circle	685

Table 1 - Building Density for 22 Scenes and 9 Cities in Multipath Modeling

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Contrary to Straight Path's argument, the results that Boeing included in its May 15 presentation also included sloped roofs at varying angles on all single family homes. This can be clearly seen in Figure 2, which overlays the building profiles, including rooftops and slopes for all homes and detached structures, even when not expressed explicitly in the OSM Buildings model.



Figure 2 - Suburban Houston (Lawndale) UMFUS CPE Receiving a Mixture of Satellite Clear LOS and Reflected Signals Off Walls and Sloped Roofs

Using these fully representative scenes results in thousands of potential reflecting surfaces to be analyzed. Boeing's modeling computed all possible reflection trajectories (including double reflections) to identify situations where the actual physical geometry enables a relevant reflection (*i.e.*, a reflective signal that could be received by the subject UMFUS receiver). The number of possible reflections that was analyzed ranged from one million per time step to more than two billion per time step in some of the denser scenes. The results of the detailed ray-tracing of specific scenes are quantified in Figure 3 below, showing the number of valid line-of-sight ("LOS") and reflective paths arriving at a single receiver location for various scenes. As shown in Figure 3 below, the total number of incoming multipath signals at the victim receiver is more than two to three times the number of satellites in view and peaks above 50 in some scenarios. The fact that billions of reflective combinations were analyzed and only 30 to 50 of the paths proved relevant to the interference analysis provides good insight into how complex the geometric conditions are in a multipath scenario.

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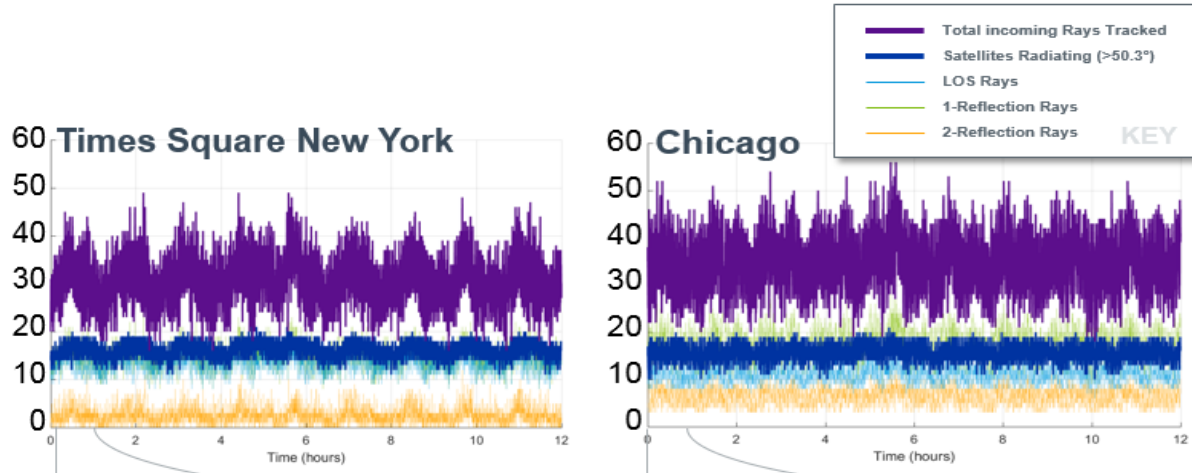


Figure 3 - Examples of Number of Valid Signal Paths Resulting in Multipath Interference Scenarios (Number of NGSO Satellites = 10 to 15)

In addition to determining which reflections had a path to the receiver, Boeing's model also tracked the angle of arrival of the signals and applied the appropriate reflection coefficients and UMFUS receiver antenna gain to each signal to assess accurately the impact of each signal on the victim receiver. This is in stark contrast to Straight Path's analytical approximation, which used "average" reflection values and a "threshold" angle within which degradations were incorrectly assumed to be a constant value.

Defects in Straight Path's Analysis

As explained above, Straight Path's approximation analysis of reflection contains a number of assumptions and over-simplifications that render the results inapplicable to real world scenarios and exaggerates the potential impact of satellite interference. This is surprising given Straight Path's primary criticism that Boeing's satellite downlink interference analysis does not take into account real-world deployment conditions. Boeing provides a partial list of these oversimplified assumptions that lead to overstated interference results:

- a) Straight Path assumes all reflections arrive with an average single reflection PFD value (rather than computing the actual angle and reflection coefficients);
- b) Straight Path assumes all reflections that arrive within an azimuth angle produce a certain degradation value (rather than applying the correct 5G antenna gain to the correct PFD level from item a) above);

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- c) Straight Path ignores the elevation beamwidth of the 5G base station beam and assumes that all reflections within an azimuth range cause interference at any radius from the base station;
- d) Straight Path ignores blockage of other structures between the reflecting roof and the base station;
- e) Straight Path generally assumes all rooftops are potential reflectors without alignment and spacing of roof planes. Straight Path attempts to model randomly oriented rooftops but does not account for the probability of the roof alignments toward a victim receiver in a single scenario; and
- f) Straight Path assumes satellites are uniformly distributed, but does not account for the fact that some satellites that are in view of a location may not be transmitting toward that location (either because of satellite alignment events or to conserve satellite system capacity).

As demonstrated by Boeing's modeling, accurate multipath assessments require more detailed treatment than was undertaken by Straight Path. The results submitted in Boeing's May 15 presentation confirm that the impacts of multipath signals, while present, do not add appreciably to interference conditions as compared to clear LOS, nor do they increase significantly the probability of these interference levels into an UMFUS receiver. Nevertheless, Boeing continues to recommend that EPFD regulations based on clear LOS calculations do incorporate Boeing's multipath analysis.³¹

Satellite Operations During Rain Fade

In its May 17 *ex parte* letter, Straight Path makes a further set of erroneous misrepresentations regarding Boeing's analysis and proposed satellite operations in rain fade conditions. Straight Path observes that "due to the large size of satellite spot beams, satellite transmitters cannot contain the power increase to only the proximity of the intended ground stations affected by rain fade events."³² This is precisely why all of Boeing's EPFD analysis assume the victim 5G receiver is in a clear-sky condition and receives the full impact of the satellite transmissions reduced only by free-space loss (as specified in the ITU S.1523 definition for Method A EPFD calculations).

Straight Path also contends that "Boeing asks for 12-dB higher PFD limit because Boeing is not able to build satellite transmitters and FSS systems that can effectively combat rain fade

³¹ *Boeing Multipath Ex Parte*, Attachment A at 14

³² *Straight Path Letter* at 11.

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events.”³³ Nothing could be further from the truth. Since the 1990s, Boeing has manufactured satellite systems that incorporate downlink power control and adaptive modulation/coding techniques. These systems are deployed and proven on-orbit and are highly effective in combating rain fade events. Power control is selectively applied only to the affected region(s), and only during rain fade events. As a result, Boeing is able to confidently state that the predicted minimal impacts to UMFUS operations (which are computed in rain and with the UMFUS receiver in an unlikely clear-sky condition) will be experienced for only a tiny fraction of the time. As Boeing illustrated to the Commission in its November 21, 2016 *ex parte* letter, a link degradation that is exceeded only two percent of the time in a heavy rain fade (which itself has a probability of occurring only two to five percent of the time) is equivalent to a degradation that is exceeded only $\sim(0.02)*(0.05) = 0.0001$ or 0.1 percent of the time.³⁴ Even though such results still include a conservative assumption of randomly and upwardly pointed UMFUS receiver beams, they satisfy Straight Path’s unrealistic and arbitrary expectation of experiencing interference “less than 0.1 percent of the time.”³⁵ In reality, to be successful at mmW operations and deployment, 5G systems will need to be designed to overcome link variations larger than 0.5 dB occurring more rapidly than rain fades or satellite reflections, and much more often than 0.1 percent of the time.

Straight Path also suggests that satellite gateway operators should employ site diversity (termed “MIMO” by Straight Path) to combat rain fade.³⁶ Satellite system operators typically do use site diversity for gateway stations to address rain fade and otherwise ensure system reliability, though usually only in heavy rain fade regions (such as the southeastern United States). These sites are used for rain fades that exceed the power capabilities of the satellite or would exceed the limits of the Commission’s rules. The use of such diversity would require satellite operators to maintain multiple additional gateway sites separated by some tens of kilometers, which would further increase the number of gateway earth stations needed for satellite network operations, an outcome Straight Path has strenuously opposed.³⁷ In contrast,

³³ *Id.*

³⁴ See Letter from Bruce A. Olcott, Counsel to The Boeing Company, to Marlene H. Dortch, Secretary, Federal Communications Commission, GN Docket No. 14-177 *et al.*, at 7-8, Table 2 (Nov. 21, 2016)

³⁵ *Straight Path Letter* at 7 (asserting that “[w]e consider the reflected satellite interference “acceptable” if it causes more than 0.5 dB rise of noise floor less than 0.1% of the time). Though current FSS interference analyses may meet this criteria, Boeing disagrees with this overly conservative assumption as it implies data rate availability numbers of >99.99% which are far beyond the achievable numbers in the UMFUS environment due to numerous other factors besides potential satellite downlink interference.

³⁶ See *id.* at 11.

³⁷ See *id.* at 13; see also Letter from Davidi Jonas, President and CEO Straight Path Communications Inc., to Marlene H. Dortch, Secretary, Federal Communications Commission, GN Docket No. 14-177, *et al.* (May 26, 2017).

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Boeing's analyses are clear in demonstrating that UMFUS receivers will experience minimal impacts resulting from satellite downlink transmissions in the 37/39 GHz band regardless of the type of earth station employed, be it gateway or end user terminal. As the satellite end user terminals would operate in the 37/39 GHz band only on an opportunistic basis, this should greatly reduce any concerns by 5G proponents regarding the degree of satellite network deployment or its impact on UMFUS operations.

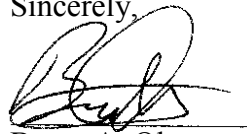
Conclusion

The Commission's *Further Notice* recognized the potential for robust spectrum sharing in the 37/39 GHz band by permitting broadband satellite systems to operate downlink transmissions to end user receivers at the power levels that already exist in the Commission's rules for both clear sky and rain fade conditions.³⁸ In considering the potential benefits of such spectrum sharing, the *Further Notice* directed all parties to "provide detailed technical studies that explicitly list the assumptions they made concerning both terrestrial and satellite operations."³⁹ Boeing alone has met this challenge, dedicating its experts and thousands of hours of computer analysis to meet and exceed its burden of proof that broadband satellite systems can operate on an opportunistic basis in the 37/39 GHz band without resulting in appreciable interference to UMFUS licensees.

The satellite industry is already using mmW to provide broadband services to consumers in all locations in the country. The Commission should therefore recognize that expanded use of mmW frequencies by broadband satellite systems serves its public interest mandate to use spectrum resources in a highly efficient manner to benefit all Americans. This can best be achieved by adopting the measures identified by Boeing in its comments on the *Further Notice* and in its petition for reconsideration of the July 14, 2016 order in this proceeding.

Thank you for your attention to this matter. Please contact the undersigned if you have any questions.

Sincerely,



Bruce A. Olcott

Counsel to The Boeing Company

³⁸ See Use of Spectrum Bands Above 24 GHz For Mobile Radio Services, et al., GN Docket No. 14-177, et al., Report and Order and Further Notice of Proposed Rulemaking, FCC 16-89, ¶¶ 497-499 (July 14, 2016).

³⁹ *Id.*, ¶ 499.